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CIRCULAR No. 12 DECEMBER, 1927
UNITED STATES DEPARTMENT OF AGRICULTURE
WASHINGTON, D. C.

DAIRY WORK AT THE WOODWARD FIELD STATION, WOODWARD, OKLA., 1921 TO 1926

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INTRODUCTION

The initial appropriation for livestock work at the Woodward Field Station, Woodward, Okla., was made by Congress for the fiscal year 1921. Dairy work was begun in June, 1921, when a herd consisting of six purebred Holstein cows, five 2-year-old heifers and one heifer calf, was purchased, and a herd sire was sent to Woodward from the dairy experiment farm at Beltsville, Md. The city of Woodward purchased 160 acres of land adjoining the field station of the Bureau of Plant Industry to be used as a livestock-demonstration farm.

The farming operations and the financial matters of the dairy farm are handled by E. F. Chilcott, superintendent of the Bureau of Plant Industry station. C. J. Stauber was placed in immediate charge of the herd and is still serving in that capacity.

The dairy experiment farm at Woodward, Okla., was established (1) to serve as a demonstration farm for modern methods of dairy husbandry in a region where dairy farming was just starting, (2) to carry out feeding experiments with feeds that could be grown locally, and (3) to carry out a part of the breeding projects that are in operation at all the branch stations of the Bureau of Dairy Industry.

Appropriations have been made by Congress for the erection of the necessary buildings and for the maintenance of the work. The following buildings have been erected: A dairy barn, young-stock barn, feed barn, and milk house, all of hollow-tile construction; a frame cottage for the herdsman; a hollow-tile silo; and a pit silo with the part above ground made of hollow tile. (Fig. 1.)

The experimental work comprises: (1) Feeding and management practices; (2) records of production; (3) studies on growth and cost of raising heifers from birth to 2 years of age; (4) pasture experiments with Sudan grass, winter wheat, rye, and sweet clover; (5) the determination of the effect of pasturing on the grain yield of winter wheat; (6) experiments in breeding cattle that will be pure in their inheritance for high-producing ability for milk and butterfat yields.

FEEDING AND MANAGEMENT PRACTICES

Each cow receives all the roughage feeds and pasture she can eat and, in addition, grain according to the amount of milk she is producing. All cows are dried off and given a rest of four to six weeks before each freshening. During this dry period some grain is fed.

The following grain mixture is used for milking cows: 3 parts, by weight, of ground kafir, 3 parts of wheat bran, 1 part of linseed-oil meal, and 1 part of cottonseed meal. This mixture contains 16 per cent digestible protein and 72 per cent total digestible nutrients. It is fed to the cows not on official test at the rate of 1 pound of grain to every 4 pounds of milk produced per day.

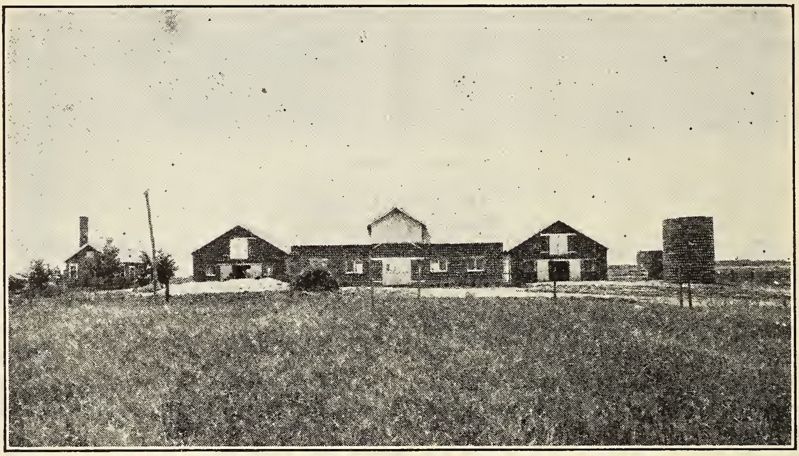

FIG. 1.—Buildings at the dairy experiment farm, Woodward, Okla. From left to right, milk house, cow barn, feed barn, young-stock barn, and silos

Alfalfa hay and small quantities of Sudan-grass hay form the bulk of the dry roughage, and silage made from kafir with most of the heads clipped off is used almost exclusively as a succulent roughage in addition to pasture. In 1926 corn was grown and made into silage. The pasture includes Sudan grass, winter rye, winter wheat, and sweet clover grown in connection with the pasture experiments.

When cows are on flush pasture they receive 1 pound of the grain mixture to each 6 pounds of milk produced per day. Later in the season when the pastures are not so good, 1 pound of grain mixture is fed to each 5 pounds of milk produced. Hay and silage are also fed as supplements to the pastures.

Cows on official test are fed a grain mixture composed of 4 parts, by weight, of ground kafir, 2 parts of wheat bran, 2 parts of linseed-oil meal, and 1 part of cottonseed meal. This is fed at the rate of 1 pound of grain to each 3½ pounds of milk produced per day. This mixture contains 17.2 per cent of digestible protein and 74.8 per cent of total digestible nutrients. The cows on official test are milked three times a day. Like the cows in the milking herd, they are kept in stanchions when in the barn. Thus the only difference between the cows on official test and those in the milking herd is that the former receive a little more grain and are milked three times daily, whereas the latter are milked only twice daily.

All heifer calves are raised to maturity. The present practice is to feed the calves whole milk for three weeks. Beginning with the twenty-second day, skim milk is substituted for a part of the whole milk. The quantity of skim milk is increased each succeeding day, until at the end of the fourth week no whole milk is fed. They are given some grain mixture when they are 2½ to 3 weeks old, and hay is fed when they are 1 to 1½ months of age. They are not placed on pasture until they are at least 6 months of age.

For a time the calves born in the Woodward herd were fed on whole milk until they were 2 months old and were then changed gradually to skim milk. By the time they were 3 months old they received no whole milk. The growth of calves fed in this manner is being compared with that of calves receiving whole milk until only 1 month of age.

The grain mixture fed to calves is composed of 5 parts, by weight, of ground kafir, 3 parts of wheat bran, and 2 parts of linseed-oil meal. This mixture contains 14.3 per cent digestible protein and 73.8 per cent total digestible nutrients.

The heifer calves are given enough feed to keep them thrifty and growing well. As 2-year-olds they are given a 365-day official test of their production, and they are bred to freshen two months after this test is completed. Cows not on official test are bred the third month of their lactation and are given a rest of four to six weeks before again freshening.

RECORDS OF PRODUCTION

Official records and herd records are kept of the milk and butterfat produced.

OFFICIAL RECORDS

Official tests are carried out as a part of the general breeding experiments of the Bureau of Dairy Industry. All cows are given an official test for milk and butterfat production under the rules of the Advanced Registry of the Holstein-Friesian Association.[1] Whenever possible they are tested as 2-year-olds and later as mature cows. The production record made in this official test is taken as the producing capacity of the animal tested and is used in the hereditary studies of milk and butterfat production. These official tests are on a 365-day basis. As far as possible the cows are bred to freshen two months after their year's record has been completed.

By January 1, 1927, 22 cows in the Woodward herd had made advanced-registry records. These records show an average yearly production of 14,650 pounds of milk and 507 pounds of butterfat at an average age of 3 years 5 months. Thirteen of the records were made by heifers at an average age of 2 years 2 months that had an average yearly production of 13,880 pounds of milk and 457 pounds of butterfat. The remaining nine records were made by cows at an average age of 5 years that had an average yearly production of 16,430 pounds of milk and 578 pounds of butterfat.

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[1] HOLSTEIN-FRIESIAN ASSOCIATION OF AMERICA. OUTLINES OF THE ADVANCED REGISTRY SYSTEM OF THE HOLSTEIN-FRIESIAN ASSOCIATION OF AMERICA AND RULES FOR OFFICIALLY AUTHENTICATED BUTTERFAT TESTS. Ed. 6, 47 p., illus. Holyoke, Mass. 1910.

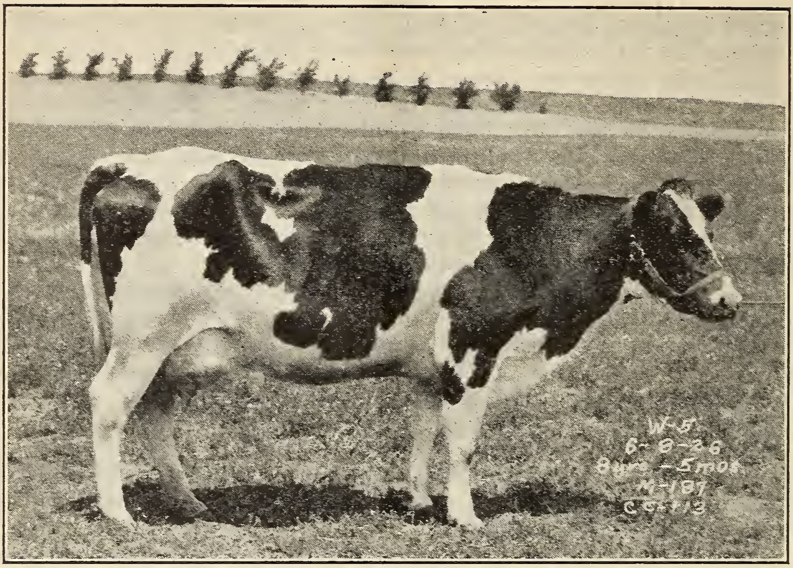

FIG. 2.—Terra Firma Ormsby Iris 439839. (Photograph taken when 8 years 5 months old.) Production records—1922–23: Milked three times a day; 19,419 pounds milk; 761.79 pounds butterfat. 1923–24: Milked twice daily; 14,356 pounds milk; 529.81 pounds butterfat. 1924–25: Milked twice daily; 13,980 pounds milk; 508.16 pounds butterfat

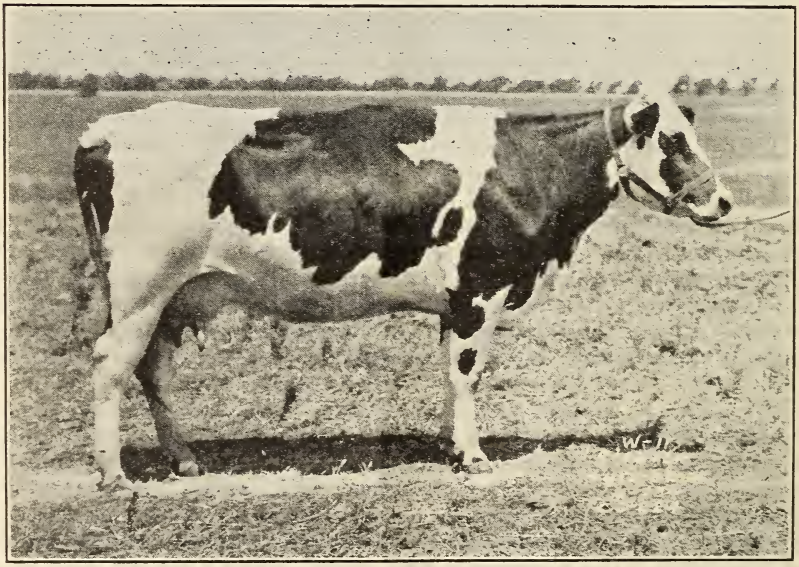

FIG. 3.—Lady Hengerveld Segis Piebe 663917. (Photograph taken when 4 years 6 months old.) Production record: 584 pounds of butterfat at 2 years 5 months

HERD RECORDS

The average annual production of all cows in the herd from 1921 to 1926 is given in Table 1. The average number of days in milk per cow varied for different years, depending upon the number of cows freshening, the number of heifers with their first calf, and the number of cows on official test. The herd increased so rapidly that it was necessary to reduce its size in order to handle it properly with the available barn facilities. Accordingly, in 1924 six of the cows were lent to the Utah Experiment Station for cooperative breeding experiments.

TABLE 1.—*Average annual production and feed cost per cow for five years*

Year	Average number of cows in milk	Average number of days in milk	Milk production	Butterfat production		Feed cost
			Pounds	*Per cent*	*Pounds*	
1921–22	8.0	334	10,651	3.61	384	$65.85
1922–23	11.6	270	11,967	3.59	429	97.11
1923–24	11.4	306	10,800	3.34	360	117.43
1924–25	8.7	347	12,210	3.32	404	86.68
1925–26	13.3	336	11,277	3.40	383	78.78

STUDIES ON GROWTH AND COST OF RAISING HEIFERS

Detailed records have been kept of the feed consumed by 17 Holstein heifers from birth to 2 years of age. These calves received whole milk until they were 2 months of age. Skim milk was then substituted gradually for whole milk, until at the end of the third month skim milk alone was being fed. Some of these heifer calves received skim milk until they were 16 months of age. A comparison of the quantities of feed given by six-month periods is shown in Table 2.

TABLE 2.—*Average feed consumption of 17 dairy heifers*

Feeds	First 6 months	Second 6 months	First year	Third 6 months	Fourth 6 months	Second year	Total, 2 years
Whole milk ..... pounds	1,023		1,023				1,023
Skim milk ..... do	1,896	3,078	4,974	268		268	5,242
Grain mixture ..... do	417	579	996	430	345	775	1,771
Hay, alfalfa ..... do	252	422	674	512	383	895	1,569
Hay, Sudan and kafir ..... do	131	241	372	293	316	609	981
Kafir silage ..... do	351	756	1,107	1,719	1,528	3,247	4,354
Pasture ..... days	19	64	83	73	104	177	260

The cost of the various feeds given these heifers varied from year to year. For purposes of comparison the following prices have been used for the whole period: Whole milk, $1.72 per hundredweight; skim milk, 35 cents per hundredweight; grain mixture (largely kafir), $25.80 per ton; alfalfa hay, $14 per ton; Sudan-grass hay and kafir hay, $10 per ton; kafir silage, $5 per ton; pasture, 75 cents per month during the first year and $1.50 per month during the second year.

At these prices the cost of the feed for the first year averaged $59.27 and for the second year $37.21, making a total of $96.48 for the two years. This high cost is due in part to the feeding of whole milk to such an advanced age.

Ten of these heifers averaged 87 pounds at birth, 438 pounds when 6 months old, 733 pounds when 12 months old, 930 pounds when 18 months old, and 1,072 [2] pounds when 2 years old, and dropped calves at an average age of 2 years and 3 months.

Table 3 gives a comparison of the average weights of heifer calves at the dairy experiment farm at Beltsville, Md., Ardmore, S. Dak., and Woodward, Okla. Table 4 gives a comparison of the average daily gains of the heifers at these stations by six-month periods.

TABLE 3.—*Comparison of the average weights of heifer calves at three field stations*

Age of calf	Average weight of calves at—		
	Woodward, Okla. (10 heifers)	Ardmore, S. Dak. (17 heifers)	Beltsville, Md. (27 heifers)
	Pounds	*Pounds*	*Pounds*
At birth	87	90	97
3 months	266	238	197
6 months	438	403	360
9 months	595	515	506
12 months	733	590	627
15 months	817	689	745
18 months	930	752	840
21 months	[1] 1,000	860	943
24 months	[1] 1,072	973	1,056

[1] The average weight of 5 heifers.

TABLE 4.—*Comparison of average daily gains in weight of heifers at three field stations*

Station	Average daily gain—			
	First 6 months	Second 6 months	Third 6 months	Fourth 6 months
	Pounds	*Pounds*	*Pounds*	*Pounds*
Woodward, Okla	1.92	1.61	1.08	0.78
Ardmore, S. Dak	1.71	1.03	0.88	1.21
Beltsville, Md	1.44	1.46	1.16	1.18

The heifers at the Woodward station received some whole milk up to the age of 3 months and were fed skim milk until 12 months of age. The heifers at Beltsville and Ardmore received whole milk for the first month only and received no skim milk after the sixth month.

The additional two months of whole-milk feeding probably accounts for the greater gain of the Woodward heifers during the first six months, and the continued feeding of skim milk probably accounts for their greater gain during the second six months. However, they made a very much lighter gain in the fourth six months. In spite of the greater gain made by the Woodward heifers during the first year, the Beltsville heifers were only 16 pounds lighter when 2 years of age. It is possible that the smaller gain of the Woodward heifers during the fourth six months was due to their approach to mature size.

PASTURE EXPERIMENTS

Experiments have been conducted to determine the carrying capacity of pastures seeded with Sudan grass, winter wheat, winter rye, and sweet clover. The data obtained include the date of seeding, the date on which the pasture was available for grazing, the length of pasture season, the number of cow-days of pasture per acre, and the value of the feed obtained per acre from such pastures.

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[2] The average weight of five heifers.

The following method for finding the value of the pastures has been devised in the office of dairy cattle breeding investigations of the Bureau of Dairy Industry. A calculation is made of the amounts of digestible protein and total digestible nutrients necessary to maintain the cow at constant body weight and to furnish the nutrients required for the milk and butterfat produced. (Savage standards.) From the required nutrients thus calculated are deducted the nutrients in the grain and in any hay or silage that may be fed while the cow is on pasture. The difference is taken as the amount of nutrients that may be credited to the pasture. By converting these nutrients into the equivalent of hay and corn silage and finding this value by using local prices, the value of the pasture is obtained. In other words, the monetary value of the pasture is figured in terms of the monetary value of the alfalfa hay and corn silage that would be required to furnish a quantity of nutrients equal to that furnished by the pasture. Corn silage was figured at $5 per ton and alfalfa hay at $14 per ton.

SUDAN-GRASS PASTURE

Sudan grass is closely related to the other cultivated sorghums, but it is very leafy and makes a finer growth. Cattle like it because of its rather sweet taste. It is much like Johnson grass but does not have the objectionable rootstocks found in the Johnson grass. It is drought and heat resistant and makes a good pasture in late summer. Sudan grass for pasture is rapidly gaining in favor. It makes its greatest growth and produces the most feed during the months of July, August, and September, when native pastures are least productive. The best results at the Woodward station were obtained when Sudan grass was seeded after the soil was thoroughly warmed, usually in June. Pasture was available four or five weeks after seeding.

Pasture experiments with Sudan grass began July 2, 1921, and have been continued each year since that date. In 1921 the grass was seeded with a grain drill. In 1922 three plots were sown with a grain drill at the rates of 30, 20, and 10 pounds of seed per acre, respectively; and two plots were seeded with a two-row planter at the rates of 2½ and 6 pounds per acre. In 1923 half the pasture plots were drilled with 10 pounds of seed per acre, and the other half were planted in rows 44 inches apart with 6 pounds of seed per acre. The seeding in 1924 and 1925 was similar to that in 1923. In 1926 the entire 5 acres was sown with a grain drill.

In 1921 a crop of wheat had been harvested from the plots before the Sudan-grass seed was sown, and this left the soil with practically no moisture. However, the plots drilled with Sudan grass July 2 were ready for grazing August 1 and were pastured until October 15, a period of 76 days, which is equivalent to 40 days of pasture per acre for one cow.

In 1922 the seed was drilled June 5; and pasturing began July 1 and ended October 12, a period of 102 days. Some hay was cut from these pasture plots. In calculating the value of the pasture, credit was given for this hay. The number of cow-days secured per acre varied in the different pasture plots from 34 to 40.

In 1923, because of the small amount of precipitation from June 18 to September 13 and the excessively hot weather, the pasture dried up badly. After the rains of late September had revived the Sudan grass it was ruined by a hailstorm on October 2. The drilled Sudan grass gave 43 cow-days of pasture for the season, and the Sudan grass planted in rows gave 30 cow-days per acre.

In 1924 the rainfall was above normal, and heavy rains had occurred in the fall of 1923. The drilled Sudan grass was pastured at intervals over a period of 115 days, from July 14 to November 5, when a killing frost occurred.[3] The Sudan grass planted in rows was pastured from July 21 to November 5. The former grass gave 93 cow-days of pasture per acre and the latter 75.

In 1925, because of dry-weather conditions during the late spring months, planting was delayed until June 16. Pasturing began July 25 and lasted until October 19 for the drilled Sudan grass, and until October 3 for the grass planted in rows. On October 19 a killing frost occurred which brought the pasture season to a close. Seventy-two cow-days of pasture per acre were secured on the drilled Sudan grass, and 47 cow-days on the Sudan grass planted in rows.

In 1926, 5 acres were seeded to Sudan grass. The pasture season began July 25 and extended to October 16, a period of 84 days. The cows were taken off pasture from September 14 to September 18 on account of the slow growth of the grass. A killing frost on October 16 brought the pasture season to a close. The precipitation from June to October, inclusive, was above normal, being 19.94 inches. For the past 13 years the average for these five months has been 13.70 [4] inches. On account of this increased rainfall during the pasture season, the grass grew better than usual and gave 121 cow-days of pasture per acre. The highest previous pasture-day record, 93 cow-days per acre, was secured in 1924.

Table 5 gives the results obtained from the Sudan-grass pasture experiments.

The calculated values of Sudan-grass pasture, including all the methods of seeding, averaged $7.83 per acre in 1921, $8.77 in 1922, $8.53 in 1923, $16.57 in 1924, $8.85 in 1925, and $20.14 in 1926. This gives an average of $11.78 per year for the six years.

TABLE 5.—*Results of Sudan-grass pasture experiments, 1921 to 1926, inclusive*

Year	Method of seeding	Quantity of seed per acre	Pasture season (dates)	Length of pasture season	Cow-days per acre	Acres needed per cow per season	Milk produced per acre	Milk produced per acre per cow-day	Average daily equivalent of the pasture in terms of—		Value of pasture for season, per acre	Value of hay cut per acre, at $10 per ton	Total value per acre
									Corn silage	Alfalfa hay			
		Lbs.		*Days*	*Days*	*Acres*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*			
1921	Drilled	------	Aug. 1–Oct. 15	76	41.4	1.83	1,401.0	33.8	35	14.5	$7.83	-----	$7.83
1922	Drilled	30	July 1–Oct. 12	104	34.0	3.06	1,336.0	39.3	37	14.0	6.48	$0.95	7.43
	In rows	2½	do	104	36.0	2.90	1,412.8	39.2	40	15.0	7.38	1.40	8.78
	Drilled	20	do	104	34.0	3.06	1,389.4	40.9	43	15.0	7.22	1.00	8.22
	In rows	6	do	104	40.0	2.60	1,484.0	37.1	43	14.0	8.22	1.72	9.94
	Drilled	10	do	104	40.0	2.60	1,499.4	37.5	43	14.0	8.22	1.25	9.47
1923	do	10	July 9–Oct. 1	85	43.0	1.98	2,151.2	50.0	45	17.5	10.11	-----	10.11
	In rows	6	July 22–Sept. 23	64	30.0	2.47	1,471.1	49.0	45	17.0	6.95	-----	6.95
1924	Drilled	10	July 14–Nov. 5	115	93.0	1.23	3,827.6	41.3	40	15.0	18.24	-----	18.24
	In rows	6	July 21–Nov. 5	108	75.0	1.44	2,621.6	35.0	40	15.0	14.89	-----	14.89
1925	Drilled	10	July 25–Oct. 19	87	72.0	1.21	1,213.5	16.7	32	11.0	10.30	-----	10.30
	In rows	6	July 25–Oct. 3	71	47.0	1.51	969.9	20.6	34½	11.5	7.41	-----	7.41
1926	Drilled	10	July 25–Oct. 16	84	121.0	.69	4,142.1	34.3	40½	13.5	20.14	-----	20.14

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[3] When Sudan grass has been killed or its growth has been checked by frost, to which it is very sensitive, there is some danger of its developing prussic acid, which may be fatal to livestock. To avoid the possibility of loss, Sudan grass is not pastured after frost.

[4] Data obtained from Woodward Field Station of the Bureau of Plant Industry.

Comparisons of Sudan grass sown in 1922 with a grain drill at the rates of 30, 20, and 10 pounds of seed per acre showed that the most pasturage was obtained when 10 pounds of seed were used. In the same year the Sudan grass planted in rows 44 inches apart with 6 pounds of seed per acre gave better results than when only 2½ pounds of seed per acre were planted. Since 1922, therefore, the rate of seeding has been 10 pounds of Sudan-grass seed per acre when sown with a grain drill and 6 pounds when planted in rows 44 inches apart.

Up to 1925, comparisons were made of Sudan-grass pasture seeded with a grain drill and that planted in rows 44 inches apart. The average number of cow-days secured for four years from drilled pastures was 62, whereas the average number was only 48 when the grass was planted in rows. The value of the former pasture averaged $12.03 per acre, and the latter averaged $9.80 per acre, for the four years.[5] Two cultivations were necessary before the grass planted in rows was ready for pasturing. It seems clear that the Sudan-grass pasture seeded with a grain drill is superior to that planted in rows.

The growth of Sudan grass is largely influenced by the amount of moisture in the soil. Table 6 gives the monthly precipitation for the 1921–1926 period and the average monthly rainfall for the period 1914–1926, inclusive.

TABLE 6.—*Monthly precipitation, in inches, 1921 to 1926, and the average monthly rainfall for the period 1914 to 1926, inclusive*

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total for year
1921	2.22	0.61	1.33	1.80	1.91	5.78	2.50	5.11	2.94	0.01	0.00	0.11	24.32
1922	1.02	0.96	5.08	2.97	3.69	0.18	1.07	2.31	2.83	0.74	1.15	0.00	22.00
1923	T.	0.06	1.86	2.32	8.11	4.20	0.69	0.39	9.33	11.99	0.89	0.84	40.68
1924	0.03	0.81	2.96	3.14	0.78	1.46	3.07	3.40	3.22	2.29	1.90	1.48	24.54
1925	0.14	0.12	0.40	3.18	1.34	2.06	2.34	0.79	2.44	0.70	2.04	0.46	16.01
1926	0.54	0.11	1.89	1.70	2.23	3.51	5.18	1.79	3.37	6.09	1.09	1.34	28.84
13-year average	0.75	0.67	1.61	2.62	3.15	2.87	2.14	2.61	3.26	2.74	1.10	0.78	24.30

WINTER-RYE PASTURE

During the fall of 1923, experiments were started to determine the value of winter rye as a fall, winter, and spring pasture. Five acres were seeded to winter rye at the rate of 1¼ bushels per acre. The field was divided into two plots, each of which was grazed alternately during the experiment. Because of insufficient growth during the fall and winter of 1923–24, the rye was not available for grazing until March 18, 1924. The season extended to May 3, a period of 47 days. Three mature Holstein cows in milk were used in the experiment. The 5 acres furnished an equivalent of 129 days of pasture, or 26 cow-days per acre, the cows being off pasture 4 days on account of rainy weather. The cows produced 1,277 pounds of milk per acre and consumed 251 pounds of grain in addition to the pasture. Computing the value of the pasture by the same method as that used for Sudan-grass pasture gave $6.07 per acre as the value of the winter-rye pasture.

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[5] Using 10 pounds of seed per acre when drilled, and 6 pounds when seeded in rows for years 1922–1925.

In 1924–25 the rye experiment was conducted in the same manner as in the preceding year. The grazing season began March 10 and extended to May 21, a period of 73 days. The 5 acres, however, did not furnish continuous grazing for the three cows throughout the entire period. It was necessary to remove them several times to other rye pastures and to return them to the experimental pasture when the rye was sufficiently long for grazing. An equivalent of 90 days of pasture, or 18 cow-days per acre, was obtained. The cows produced 498 pounds of milk per acre and consumed 111 pounds of grain. Computing the value of the pasture by the method previously given gave a value of $3.13 per acre.

In 1925–26, 5 acres were seeded to rye as in the previous two years. The pasture season began March 14 and extended to May 25, a period of 73 days. The cows produced 2,242 pounds of milk per acre and consumed 411 pounds of grain. The computed value of the pasture was $13.61 per acre.

Table 7 gives the summary of the results of the three years' work with rye pastures.

TABLE 7.—*Results of winter-rye-pasture experiments, 1924 to 1926, inclusive*

Crop year	Pasture season	Length of pasture season	Cow-days per acre	Milk per acre per cow-day	Equivalent of pasture		Monetary value of pasture
					Corn silage per day	Hay per day	
		Days		*Pounds*	*Pounds*	*Pounds*	*Dollars*
1923–24	Mar. 18–May 3	47	26	49.1	43.0	18.0	6.07
1924–25	Mar. 10–May 21	73	18	27.6	36.0	12.0	3.13
1925–26	Mar. 14–May 25	73	60	37.0	46.5	15.5	13.61

The pasture season of this crop ends early enough to permit planting another feed or pasture crop like Sudan grass, if the season is not too dry.

WINTER-WHEAT PASTURE

During the fall of 1924 an experiment was started to determine the possibilities of winter wheat for fall, winter, and spring pastures, the purpose being to ascertain the length of time winter wheat may be grazed and the number of animals which can be maintained on an acre of wheat pasture. Four acres were sown to Kanred winter wheat at the rate of 1½ bushels per acre. Because of insufficient growth the wheat was not ready for grazing until March 9, 1925. The season extended to May 21, a period of 74 days. The 4 acres furnished grazing for six young Holstein cows for 168 cow-days, or 42 cow-days per acre. The production per acre was 1,766 pounds of milk; and the feed consumed in addition to pasturage was 312 pounds of grain, 241.5 pounds of alfalfa hay, and 182 pounds of kafir silage per acre. In terms of the monetary value of the alfalfa hay and corn silage which it replaced, the wheat pasture was worth $7.50 per acre.

In 1925, 3 acres were seeded to Kanred wheat, as in the previous year. On account of dry fall conditions, there was not sufficient pasture until March 14, 1926. The season extended to May 22, a period of 70 days, and 46.7 cow-days per acre of pasture grazed were obtained. The production per acre was 1,602 pounds of milk, and the feed consumed in addition to pasture was 305 pounds of grain. The computed value of the pasture was $10.03 per acre.

The pasture season of this crop, like that of winter rye, ends early enough to permit planting another feed or pasture crop like Sudan grass, if the season is not too dry.

SWEET-CLOVER PASTURE

Five acres were sown to sweet clover April 16, 1926, and the field was ready for pasturing June 30. The number of cows on pasture varied from three to six, according to the growth of the sweet clover. On account of dry weather, the cows were taken off pasture from August 20 to November 6. The season ended November 27 and 77.8 cow-days per acre had been secured. The production was 2,476.8 pounds of milk and 76.7 pounds of butterfat per acre. During the time the cows were on pasture they consumed 527 pounds of grain mixture, 201 pounds of alfalfa hay, and 715 pounds of corn silage per acre. The value of the alfalfa hay and corn silage required to furnish the same quantity of nutrients for milk production as were furnished by the sweet-clover pasture was $10.89 per acre.

Ordinarily the first year of sweet-clover seeding does not provide so much pasturage as the second year. However, this first year's pasturage compares favorably in value with the wheat, rye, and Sudan-grass pastures.

Sweet clover has an advantage over such annual pasture crops as rye, wheat, and Sudan grass, in that it comes up the second year without further land preparation or seeding. It furnishes a late pasture for the first year and a very early one the second year. The crop matures and dies in the summer of its second year.

COMPARISON OF THE VARIOUS PASTURES

Table 8 gives a comparison of the pasture-season dates and of the values per acre of the four kinds of pastures used in this experiment at the Woodward Field Station, 1921 to 1926.

TABLE 8.—*Comparison of various pastures at Woodward Field Station, 1921 to 1926, inclusive*

Kind of pasture	Number of years averaged	Pasture season	Value per acre
Winter rye	3	Mar. 10–May 25	$7.60
Winter wheat	2	Mar. 9–May 22	8.76
Sweet clover, first year	1	June 20–Nov. 27	10.89
Sudan grass, drilled	6	July 1–Nov. 5	12.50

When these experiments were begun it was hoped that a rotation of wheat, rye, sweet-clover, and Sudan-grass pastures might furnish grazing for the whole year. The experiments have shown, however, that winter wheat and winter rye are not dependable for fall and winter pasture. Although data are given later in this circular showing the effect on the grain yield of grazing wheat in the fall and winter months, in most cases it was thought that the wheat had not gained sufficient growth to furnish good pasture for the cows. In fact, where the wheat and rye were allowed to reach sufficient growth to provide plenty of feed for the cows, March 9 was the earliest date the pasture was available. Lack of moisture has been the cause of the slow growth during the fall and winter months for the period covered by these experiments.

Heretofore there has been a gap between the last pasture day of winter wheat and rye and the first pasture day of Sudan grass. From the results of the one year that sweet clover was pastured it is thought that this crop may fill in the gap. There is a possibility also that brome grass and crested wheatgrass may be worked into the rotation. A desirable feature of these two grasses is that after they are once established they do not have to be reseeded each year, as is the case with rye and Sudan grass.

YIELDS OF GRAIN AND HAY CROPS

The yields of various grain and hay crops as reported by the Woodward Field Station of the Bureau of Plant Industry are shown in Table 9.

TABLE 9.—*Grain yields per acre, 1917 to 1926, inclusive*

Year	Winter wheat	Sunrise kafir	Standard kafir	Dwarf milo	Corn
	Bushels	*Bushels*	*Bushels*	*Bushels*	*Bushels*
1917	4.6	39.5	31.4	16.3	Failure.
1918	4.7	10.3	2.2	2.9	Failure.
1919	13.9	40.4	31.8	26.7	Failure.
1920	13.0	38.0	37.6	27.3	13.8
1921	25.7	37.8	41.3	43.1	15.2
1922	23.0	15.3	16.8	21.2	1.7
1923	17.9	10.8	12.9	8.8	3.4
1924	12.5	30.1	38.0	33.3	8.7
1925	14.3	27.5	33.6	28.1	3.5
1926	17.9	36.2	39.0	33.8	16.9
10-year average	14.7	28.6	28.5	24.2	6.3
6-year average (1921–1926)	18.5	26.3	30.3	28.0	8.2

The wheat yields represent the average of three different methods of cultivation, the corn yields of five; and the Sunrise and Standard kafir yields were obtained from the variety experimental plats. The weight of the wheat is 60 pounds per bushel, and that of the kafir, milo, and corn is 56 pounds. In this experiment the bureau is not interested in the value of whole wheat as a feed for dairy cows, but it is interested in the value of the other three grains. Table 10 shows the yield per acre of Sunrise kafir, Standard kafir, dwarf milo, and corn, and the amount of total digestible nutrients in these grains. These figures are based on the average of the six-year period covered by the pasture experiments.

TABLE 10.—*Nutrients produced per acre in grain crops*

Crop	Grain yield per acre	Digestible nutrients	
		Protein	Total nutrients
	Pounds	*Pounds*	*Pounds*
Sunrise kafir	1,473	132.6	1,178.4
Standard kafir	1,613	145.2	1,290.4
Milo	1,568	141.1	1,254.4
Corn	459	34.4	393.4

It appears that with the kafirs and the milo there is no great difference in the average yield per acre of digestible protein and total digestible nutrients. Corn in the Woodward region does not furnish the amount of digestible nutrients supplied by these grains.

TABLE 11.—*Hay yields per acre*

Year	Sunrise kafir	Sudan grass	Red Amber sorgo	Cowpeas
	Pounds	*Pounds*	*Pounds*	*Pounds*
1921		5,886	6,772	3,678
1922	2,598	2,279	2,319	1,544
1923	4,684	2,653	4,329	1,171
1924	6,222	4,311	6,491	3,237
1925	6,786	3,520	6,326	1,356
1926	7,067	4,181	5,807	1,981
Average	5,471	3,805	5,341	2,161

Table 11 shows the yield of the most commonly grown hays in the Woodward region for the period of the pasture experiment.

The average yields of Sunrise kafir and Red Amber sorgo hays do not vary a great deal. Sudan-grass hay and cowpea hay rank much lower than these, the former yielding a little less than 70 per cent as much as Sunrise kafir and the latter a little less than 40 per cent as much. However, in spite of the fact that the cowpea hay has an average yield of only 37 per cent of the total digestible nutrients of the Sunrise kafir, as shown in Table 12, it yields more digestible protein per acre than either the kafir or Sudan-grass hay, as is shown by the same table. For this reason, it is possible that for milk and butterfat production the cowpea hay may be more valuable than either of the other hays.

TABLE 12.—*Nutrients produced per acre in hay crops*

Crop	Yield per acre	Digestible nutrients	
		Protein	Total
	Pounds	*Pounds*	*Pounds*
Sunrise kafir	5,471	224.3	2,894.2
Sudan grass	3,805	140.8	1,955.8
Cowpea	2,161	283.1	1,058.9

From the data given in Tables 10 and 12 the amount of digestible protein and total digestible nutrients for each of the pasture crops compared has been calculated by the method previously given for finding the value of the pastures. These data are given in Table 13.

TABLE 13.—*Nutrients produced per acre in pasture crops*

Pasture	Digestible nutrients		Pasture	Digestible nutrients	
	Protein	Total		Protein	Total
	Pounds	*Pounds*		*Pounds*	*Pounds*
Winter wheat	90.1	680.8	Sudan grass	96.5	815.5
Winter rye	72.5	548.0	Sweet clover	86.9	806.0

If the amount of nutrients from these pastures is compared with that returned when the crops were matured in grain and hay it will be seen that the pasture returns are markedly lower. Sudan grass was used both as a pasture crop and as a hay crop. A comparison of the figures given in Tables 12 and 13 shows that an acre of Sudan-grass hay yielded 45.9 per cent more digestible protein and 139.8 per cent more total digestible nutrients than did an acre of the Sudan grass when pastured.

These figures would indicate that it is more profitable in the Woodward region to allow crops to mature into grain and hay than to pasture them. It is possible that the cropping of the immature grasses under hot and dry weather conditions prevents them from reaching their maximum growth. Of course, the tramping of the pasture grass results in some wastage, but this would be offset by the wastage of coarse stems in the hay that would not be eaten. A possible source of error in such comparison is that the nutrients credited to the pasture were calculated from the yield of the cows on the pasture, whereas the nutrients credited to the hay are average analyses from Henry's Feeds and Feeding [6] applied to the average yields secured at Woodward. It does not seem, however, that the errors would be great enough to account for the differences that have been pointed out.

These differences in the digestible nutrients secured from grasses when pastured and when cut for hay suggest the necessity for an experiment in which half the acreage of a crop will be pastured and the other half cut for hay and the milk yield produced from the hay and the pasture compared.

EFFECT OF PASTURING UPON THE GRAIN YIELD OF WINTER WHEAT

It is a practice in the vicinity of Woodward to pasture winter wheat during the fall and winter months and then allow it to ripen into a grain crop. In the fall of 1922, at the suggestion of J. B. Sieglinger, associate agronomist, office of cereal crops and diseases, Bureau of Plant Industry, an experiment was outlined and carried out by L. F. Locke, associate agronomist, office of dry-land agriculture of that bureau, and C. J. Stauber, assistant dairy husbandman of the Bureau of Dairy Industry, to determine what effect grazing at different periods of growth has upon the grain yield of winter wheat. Tenth-acre plots 132 feet by 33 feet in size were used in this experiment.

PASTURING METHOD

The method used in grazing these plots was as follows: A cable one-fourth inch in diameter and 132 feet long was placed across the center of the plot and staked at each end. Attached to this cable by a ring was a chain 15 feet long, to which the cow was tethered. By this method no fences were required, and the cow was able to graze an entire plot without being restaked. She was allowed to pasture the plot as long and as often as there was sufficient feed during the period the plot was to be pastured.

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[6] HENRY, W. A., and MORRISON, F. B. FEEDS AND FEEDING. Ed. 18, unabridged, 770 p., illus. Madison, Wis., 1923.

GRAZING PERIODS

During the course of the experiment it was found necessary to assign arbitrary dates to limit the various grazing periods. This was done so that the different plots could be grazed during the same periods each year. The established dates and designated grazing periods are as follows:

Fall	Available date to Dec. 15.
Winter	Dec. 15 to Feb. 15.
Spring	Feb. 15 to Apr. 15.
Fall and winter	Available date to Feb. 15.
Winter and spring	Dec. 15 to Apr. 15.
Fall, winter, and spring	Available date to Mar. 1.[7]
Fall, winter, and spring	Available date to Mar. 15.[7]
Fall, winter, and spring	Available date to Mar. 31.[7]
Fall, winter, and spring	Available date to Apr. 15.
Fall, winter, and late spring	Available date to May 1.

In 1922–23 five plots were used in the experiment; two of these served as checks and were not grazed. The other three were grazed during the following pasture periods: Winter, spring, and winter and spring.

In 1923–24 the same number of plots and the same methods of pasturing were used as in 1922–23, but the location of the plots was changed.

In 1924–25 ten plots were used, 3 as checks ungrazed and 7 grazed, as follows: Fall; winter; spring; fall and winter; winter and spring; fall, winter, and spring; and fall continuously to May 1.

In 1925–26 the size of the plots and the methods of grazing were the same as in the previous year, except that three plots were added. The reason for this addition was that in previous years the data obtained had shown that wheat pastured up to February 15 gave a considerable increase in yield over that pastured as late as April 15. It was decided, therefore, that some closer check should be made to find the specific date between February 15 and April 15 to which the wheat could be grazed without serious reduction in the grain yield. To obtain this information the three new plots were added and were grazed from the date pasture was available in the fall to March 1, to March 15, and to March 31, respectively.

Each year of the experiments 10 plants were selected at random from each plot, the height of these plants was measured, and the number of heads and spikelets counted. In 1926 the number of grains and the weight of the grains in grams were also obtained from 10 selected plants from each plot. The yield of the straw and the yield of the grain were obtained by threshing each plot individually. The results of these pasture experiments are given in Table 14.

From this table it will be seen that the effect of grazing of winter wheat varies considerably. Fall and winter grazing in 1925 and 1926 seemed to have practically no effect on the height of the plants. Grazing from December 15 to February 15 reduced the height less than 1 per cent on the average, grazing from February 15 to April 15 reduced the height 22.1 per cent, and grazing from the fall of 1925 to May 1, 1926, reduced the height 33.4 per cent.

The number of heads per 10 plants was reduced when the plots were grazed beyond February 15. In the year 1925–26, when there was an ususual amount of rainfall, there was a reduction in the number of heads in the plots grazed from fall to May 1.

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[7] Three plots were added in 1926.

TABLE 14.—*Results of pasturing on the grain yield of winter wheat, 1923 to 1926, inclusive*

Items of comparison	Year	Results on ungrazed plots				Results on plots grazed									
		Plot 1	Plot 2	Plot 3	Average	Fall to Dec. 15	Dec. 15 to Feb. 15	Feb. 15 to Apr. 15	Fall to Feb. 15	Dec. 15 to Apr. 15	Fall to Mar. 1	Fall to Mar. 15	Fall to Mar. 31	Fall to Apr. 15	Fall to May 1
Date of heading	1925	Apr. 25	Apr. 25	Apr. 25	Apr. 25	Apr. 28	Apr. 28	May 15	Apr. 30	May 15	----------	----------	----------	May 15	June 3
	1926	May 11	May 11	May 11	May 11	May 11	May 13	May 21	May 13	May 21	May 14	May 21	May 21	May 12	May 24
Date ripe	1923	June 13	June 13	----------	June 13	----------	June 13	June 15	----------	June 15	----------	----------	----------	----------	----------
	1924	June 17	June 17	----------	June 17	----------	June 19	June 24	----------	June 19	----------	----------	----------	----------	----------
	1925	June 2	June 2	June 2	June 2	June 2	June 2	June 18	June 8	June 20	----------	----------	----------	June 22	June 27
	1926	June 7	June 7	June 7	June 7	June 7	June 8	June 14	June 18	June 15	June 12	June 16	June 15	June 8	June 19
Height of plants in inches	1923	24.0	21.0	----------	22.5	----------	24.0	24.0	----------	21.0	----------	----------	----------	----------	----------
	1924	32.0	32.0	----------	32.0	----------	29.0	29.0	----------	29.0	----------	----------	----------	----------	----------
	1925	25.0	26.0	26.0	25.7	24.0	25.0	20.0	25.0	21.0	----------	----------	----------	18.0	15.0
	1926	29.6	30.1	28.7	29.5	31.5	29.9	23.0	31.3	24.1	25.4	20.7	23.7	30.2	22.1
Number of heads per 10 plants	1923	48.0	42.0	----------	45.0	----------	34.0	34.0	----------	26.0	----------	----------	----------	----------	----------
	1924	56.0	60.0	----------	58.0	----------	57.0	48.0	----------	52.0	----------	----------	----------	----------	----------
	1925	45.0	42.0	45.0	44.0	42.0	46.0	33.0	43.0	48.0	----------	----------	----------	29.0	41.0
	1926	62.0	65.0	72.0	66.3	72.0	52.0	50.0	55.0	51.0	49.0	61.0	68.0	60.0	68.0
Number of spikelets per 10 plants	1923	468	418	----------	443	----------	290	288	----------	220	----------	----------	----------	----------	----------
	1924	569	617	----------	593	----------	559	463	----------	511	----------	----------	----------	----------	----------
	1925	349	350	355	351	294	344	199	333	296	----------	----------	----------	198	261
	1926	629	627	712	656	774	565	497	617	501	461	587	661	620	748
Weight of straw per 0.1 acre (pounds)	1923	180	131	----------	155	----------	140	108	----------	134	----------	----------	----------	----------	----------
	1924	159	299	----------	229	----------	145	198	----------	208	----------	----------	----------	----------	----------
	1925	66	129	106	100	95	101	50	97	39	----------	----------	----------	32	35
	1926	137	174	146	152	171	161	88	213	99	129	115	99	155	108
Weight of grain per 0.1 acre (pounds)	1923	70	69	----------	69	----------	60	47	----------	56	----------	----------	----------	----------	----------
	1924	159	201	----------	180	----------	145	135	----------	142	----------	----------	----------	----------	----------
	1925	49	56	64	56	55	44	30	53	26	----------	----------	----------	23	10
	1926	78	96	84	86	94	89	62	112	66	81	75	66	90	52
Bushels per acre	1923	11.7	11.4	----------	11.5	----------	10.0	7.8	----------	9.0	----------	----------	----------	----------	----------
	1924	26.5	26.7	----------	26.6	----------	24.2	21.5	----------	23.7	----------	----------	----------	----------	----------
	1925	8.2	9.3	10.7	9.4	9.2	7.3	5.0	8.8	4.3	----------	----------	----------	3.8	1.7
	1926	13.0	16.0	14.0	14.3	15.7	14.8	10.3	18.7	11.0	16.5	12.5	11.0	15.0	8.7
Weight per bushel (pounds)	1923	52.0	52.0	----------	52.0	----------	53.0	55.0	----------	56.0	----------	----------	----------	----------	----------
	1924	62.0	61.0	----------	61.5	----------	61.0	62.0	----------	61.0	----------	----------	----------	----------	----------
	1925	62.0	62.0	62.0	62.0	55.0	60.0	57.0	63.0	60.0	----------	----------	----------	60.0	55.0
	1926	60.0	60.0	59.0	59.7	59.0	59.0	59.0	59.0	59.0	60.0	60.0	60.0	60.0	52.0
Number of grains per 10 plants	1926	988	1,051	1,198	1,079	1,319	875	845	991	851	659	966	1,139	985	1,162

TABLE 15.—*Results on grazed plots, given as percentages of results secured on ungrazed plots, 1923 to 1926, inclusive*

Items of comparison	Year	Average of results on ungrazed plots[1]	Results on plots grazed—									
			Fall to Dec. 15	Dec. 15 to Feb. 15	Feb. 15 to Apr. 15	Fall to Feb. 15	Dec. 15 to Apr. 15	Fall to Mar. 1	Fall to Mar. 15	Fall to Mar. 31	Fall to Apr. 15	Fall to May 1
			Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Height of plants, inches	1923	22.5		106.7	106.7		93.3					
	1924	32.0		90.6	90.6		90.6					
	1925	25.7	93.4	97.3	77.8	97.3	81.7				70.0	58.3
	1926	29.5	106.8	101.4	78.0	106.1	81.7	86.1	70.2	80.3	102.4	74.9
Number of heads per 10 plants	1923	45.0		75.5	75.5		57.8					
	1924	58.0		98.3	82.8		89.7					
	1925	44.0	95.4	104.5	75.0	97.7	109.1				65.9	93.2
	1926	66.3	108.6	78.4	75.4	83.0	76.9	73.9	93.0	102.6	90.5	102.6
Number of spikelets per 10 plants	1923	443		65.4	65.0		49.7					
	1924	593		94.3	78.1		86.2					
	1925	351	83.7	98.0	56.7	94.9	84.3				56.4	74.3
	1926	656	118.0	86.1	75.8	94.1	76.4	70.3	89.5	100.8	94.5	114.0
Weight of straw per 0.1 acre, pounds	1923	155		90.3	67.9		86.5					
	1924	229		63.3	86.5		90.8					
	1925	100	95.0	101.0	50.0	97.0	39.0				32.0	35.0
	1926	152	112.5	105.9	57.9	140.1	65.1	84.9	75.6	65.1	102.0	71.0
Weight of grain per 0.1 acre, pounds	1923	69		86.9	68.1		81.2					
	1924	180		80.5	75.0		78.9					
	1925	56	98.2	78.6	53.6	94.6	46.4				41.1	17.9
	1926	96	109.4	103.5	72.1	130.2	76.7	94.2	87.2	76.7	104.7	60.5
Bushels per acre	1923	11.5		86.9	67.8		78.2					
	1924	26.6		91.0	80.8		89.1					
	1925	9.4	97.9	77.7	53.2	93.6	45.7				40.4	18.1
	1926	14.3	109.8	103.5	72.0	130.8	76.9	94.4	87.4	76.9	104.9	60.8
Weight of grain per bushel, pounds	1923	52.0		101.9	105.8		107.7					
	1924	61.5		99.2	100.8		99.2					
	1925	62.0	88.7	96.8	91.9	101.6	96.8				96.8	88.7
	1926	59.7	98.8	98.8	98.8	98.8	98.8	100.5	100.5	100.5	100.5	87.1
Number of grains per 10 plants	1926	1,079	122.2	81.1	78.3	91.8	78.9	61.1	89.5	105.6	91.3	107.7

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[1] The average of results on ungrazed plots is taken as 100 per cent.

The number of spikelets per head was noticeably reduced when the wheat was grazed, except in 1925–26, when unusual results were obtained.

The shortening of the height of the plants, together with the smaller number of heads and spikelets, resulted in decreased yields of the grain crop.

Late pasturing delayed the maturity of the wheat several days and decreased the yield of grain as much as 60 to 65 per cent.

In 1923 the weight of the wheat per bushel on the late-pastured plots showed an increase over the wheat from ungrazed plots. That year the late-pastured plots had fewer shriveled berries, and the grain was of better quality than that from the ungrazed plots.

In 1926, with an increased rainfall, the wheat plots pastured from fall to February 15 produced 30.8 per cent more grain than the ungrazed plots. Fall-pastured plots produced 9.8 per cent more, and winter-grazed plots produced 3.5 per cent more than the ungrazed plots. The results of 1923, 1924, and 1925, however, showed an average decrease of 14.8 per cent in the wheat grazed during the winter. Grazing from date available in the fall to March 15 (1925–26) reduced the yield 12.6 per cent. Grazing to March 31 reduced the yield 23.1 per cent and grazing to May 1 reduced the yield 39.2 per cent.

Table 15 shows the results of each of the four years' experiments, the results on the grazed plots being given as percentages of the results secured on the ungrazed plots, which were taken as 100 per cent.

As will be noted, the effects of grazing on the different characteristics of wheat under observation varied widely in the different years. It is apparent also that climatic conditions affect the results. Fall, winter, and fall-and-winter grazing was beneficial to the wheat, but this was not true of grazing after February 15. The plot grazed to April 15 in 1926, however, shows an increased yield over the plots grazed to earlier and later dates of the same year.

Table 16 shows the yearly average of the data given in Table 15. Because of the extreme variation in the different years this table should be considered only in conjunction with Tables 13 and 14.

TABLE 16.—*Average of yearly results of 1923–1926 experiments shown in Table 15*

Items of comparison	Average results on ungrazed plots [1]	Average results on grazed plots expressed as percentages of the average results on the ungrazed plots									
		Fall to Dec. 15 [2]	Winter, Dec. 15 to Feb. 15	Spring, Feb. 15 to Apr. 15 [2]	Fall and winter to Feb. 15 [2]	Winter and spring, Dec. 15 to Apr. 15	Fall to Mar. 1 [3]	Fall to Mar. 15 [3]	Fall to Mar. 31 [3]	Fall to Apr. 15 [2]	Fall to May 1 [2]
Height of plants, inches	27.4	100.1	99.0	88.3	101.7	86.8	86.1	70.2	80.3	86.2	66.6
Number of heads per 10 plants	53.3	102.0	89.2	77.2	90.3	83.4	73.9	92.0	102.6	78.2	97.9
Number of spikelets per 10 plants	511	100.8	86.0	68.9	94.5	74.1	70.3	89.5	100.8	75.5	94.2
Weight of straw per 0.1 acre, pounds	159	103.7	90.1	66.0	118.5	70.3	84.9	75.6	65.1	67.0	53.0
Weight of grain per 0.1 acre, pounds	100	103.8	87.4	67.2	112.4	70.8	94.2	87.2	76.7	72.9	39.2
Bushels per acre	15.4	103.9	89.8	68.4	112.2	72.5	94.4	87.4	76.9	72.6	39.5
Weight of grain per bushel, pounds	58.8	93.8	99.2	99.3	100.2	100.6	100.5	100.5	100.5	98.6	87.9
Number of grains per 10 plants	1,079	122.2	81.1	78.3	91.8	78.9	61.1	89.5	105.6	91.3	107.7

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[1] Average of the ungrazed plots is taken as 100 per cent.

[2] This column represents the average of 1925 and 1926 only.

[3] This column represents data for 1926 only.

These data seem to show that the wheat yield under the conditions existing during this period is not injured by grazing up to February 15, but that grazing after that date under these conditions decreases the yield of grain materially. However, wheat seems to furnish very little grazing before February 15, according to the experiments carried on during the past four years.

BREEDING EXPERIMENTS

Experiments are conducted for the purpose of breeding dairy cattle that will be pure in their inheritance for high-producing ability for milk and butterfat production. It is expected that this will be accomplished by using, for generation after generation, sires that are homozygous for the factors determining high production.

THE FIRST HERD SIRE

When the herd was established in 1921, six young purebred Holstein cows, five 2-year-olds and a heifer calf, were purchased. Because of lack of funds for the purchase of a proved sire at the time the project was started, it was necessary to use an untried bull. A Holstein bull bred at the dairy experiment farm at Beltsville, Md., was therefore sent to Woodward to head the herd. This bull, Count Piebe Watson Hero 311691, was sired by King Segis Pontiac Hero 78210, a bull that has 26 daughters with yearly advanced-registry records. Eighteen of these daughters have made 365-day records averaging 638.6 pounds of butterfat when calculated to maturity; and six have made 305-day records averaging 566 pounds of butterfat when calculated to maturity.

The dam of Count Piebe Watson Hero is Watson Segis Pontiac Homestead 316969. She has made the following 365-day records at the dairy experiment farm at Beltsville:

> 20,353 pounds milk and 671.50 pounds butterfat at 2 years 2 months; 21,174 pounds milk and 759.86 pounds butterfat at 3 years 11 months; 25,360 pounds milk and 927.85 pounds butterfat at 5 years 2 months; 27,297 pounds milk and 914.84 pounds butterfat at 6 years 6 months.

Watson Segis Pontiac Homestead is a daughter of Piebe Laura Ollie Homestead King 110704 out of Watson Segis Pontiac 239071.

Piebe Laura Ollie Homestead King has 47 daughters with yearly advanced-registry records. Of these, 23 have records of more than 600 pounds of butterfat in 365 days. One daughter, May Walker Ollie Homestead 300043, holds the butterfat record in this country, having produced 1,218.59 pounds of butterfat in 365 days. Another daughter has produced 1,062.5 pounds of butterfat in 365 days.

The granddam, Watson Segis Pontiac 239071, has a record of 844 pounds of butterfat in 357 days at 5 years 1 month of age. She was sired by King Segis Pontiac Count 93909, a bull having 34 daughters with yearly records. Twenty-six of them have produced more than 600 pounds, two over 1,000 pounds, and three over 900 pounds. King Segis Pontiac Count is a full brother of King Segis Pontiac Hero, the sire of Count Piebe Watson Hero.

In view of the remarkably high-producing ancestry of Count Piebe Watson Hero, it was expected that he would sire high-producing daughters, but he did not come up to expectations. He has been used in the Woodward station herd continuously since the fall of 1921. On January 1, 1927, he had 15 first-cross daughters and 9 inbred daughters. Eight first-cross daughters in their first lactation have completed official tests that average 611.4 pounds of butterfat when calculated to maturity. The 9 inbred daughters range in age from 1 month to over 2 years. In January, 1927, one of these inbred daughters in her first month of lactation produced 1,649.8 pounds of milk and 50.75 pounds of butterfat, and another in her second month of lactation produced 1,653.5 pounds of milk and 56.22 pounds of butterfat.

A comparison of the records of seven[8] first-cross daughters of Count Piebe Watson Hero 311691 with the records of their dams is given in Table 17.

As will be noted in this table, the production of the seven daughters when calculated to maturity averaged 80.3 pounds of butterfat less than the production of their dams when calculated to maturity. On a mature basis, the production of only two of the seven daughters exceeded the production of their dams. It will be seen that this sire is apparently a failure in his ability to transmit high production uniformly to his daughters. There is, of course, a possibility that the daughters of this bull may be slower than is usual in developing their full producing capacity.

The failure of this herd sire shows that it is unsafe at the present stage of breed development to use an untried bull in a herd in which an attempt is being made to breed a pure line for high production, no matter how well bred the bull may appear to be.

Because of the records made by his first seven daughters, it was not considered advisable to use this sire any longer in the herd.

This sire has been bred back to his daughters for the past few years. On January 1, 1927, he had nine inbred daughters and the same number of inbred sons. Two of the inbred daughters are in their first lactations and are producing very well. The inbred bull calves do not appear to be of as good type as the outbred sons. They have not grown so well and seem to be lacking in chest development. The inbred daughters appear to be normal in conformation.

THE SECOND HERD SIRE

In February 1927, a new herd sire was selected and shipped to the Woodward station. This bull is King Paul Helena Walker 348317, bred by the Bureau of Dairy Industry at the dairy experiment farm at Huntley, Mont. He is a son of Mapleside King Paul 181023, whose first 12 daughters, tested as 2-year-olds in the Huntley herd, produced an average of 538.1 pounds of butterfat. This is an increased production of 64.7 pounds of butterfat over the production of their dams, when the records of both dams and daughters are calculated to maturity.

The dam of King Paul Helena Walker is Helena Colantha Walker 258544, a cow in the Huntley herd that produced 638.73 pounds of butterfat in 365 days at 5 years 6 months of age on a full-feed ration of 1 pound of grain mixture to each 3 pounds of milk produced. She also produced 558.36 pounds of butterfat in 365 days on a limited-grain ration of 1 pound of grain mixture to each six pounds of milk produced. The dam of Helena Colantha Walker is Helen Uilkje

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[8] The dam of one daughter died before completing a year's record.

TABLE 17.—*Comparison of the production records of daughters of Count Piebe Watson Hero 311691 with the records of their dams*

Daughters						Dams					
Name of cow	Age		Milk production	Butterfat production	Butterfat calculated to maturity	Name of cow	Age		Milk production	Butterfat production	Butterfat, calculated to maturity
	Years	Months					Years	Months			
			Pounds	*Pounds*	*Pounds*				*Pounds*	*Pounds*	*Pounds*
Countess Watson Johanna Piebe 833278	2	7	13, 331. 7	433. 99	542. 4	Lady Hengerveld Segis Piebe 663911	2	5	16, 458. 1	584. 04	778. 5
Countess Watson Ormsby Piebe 844642	2	4	14, 479. 7	488. 91	651. 8	Terra Firma Ormsby Iris 439839	4	8	19, 419. 8	761. 79	810. 4
Countess Watson Glen Canary 874194	2	1	13, 784. 0	425. 68	567. 4	Butter Girl Ormsby Mercedes 583516	3	6	15, 042. 0	542. 17	615. 8
Countess Watson Johanna Rue 881535	2	5	15, 998. 0	499. 92	667. 2	Appleton Johanna Rue 574402	3	7	16, 643. 3	507. 55	576. 6
Countess Watson Johanna Ruth 844644	2	1	16, 086. 4	478. 43	637. 8	Parthenea Mercedes Piebe 372703	5	11	21, 485. 2	771. 74	771. 7
Countess Watson Johanna Fayne 891872.	2	3	13, 974. 5	479. 55	639. 3	Alcartra Fayne, 2d, 308123	8	0	18, 768. 4	598. 13	598. 1
Countess Caroline Watson Segis 894946	2	1	13, 453. 1	415. 54	553. 9	Caroline Segis DeKol Pontiac 663910	3	4	15, 274. 3	570. 42	670. 8
Average					608. 5	Average					688. 8

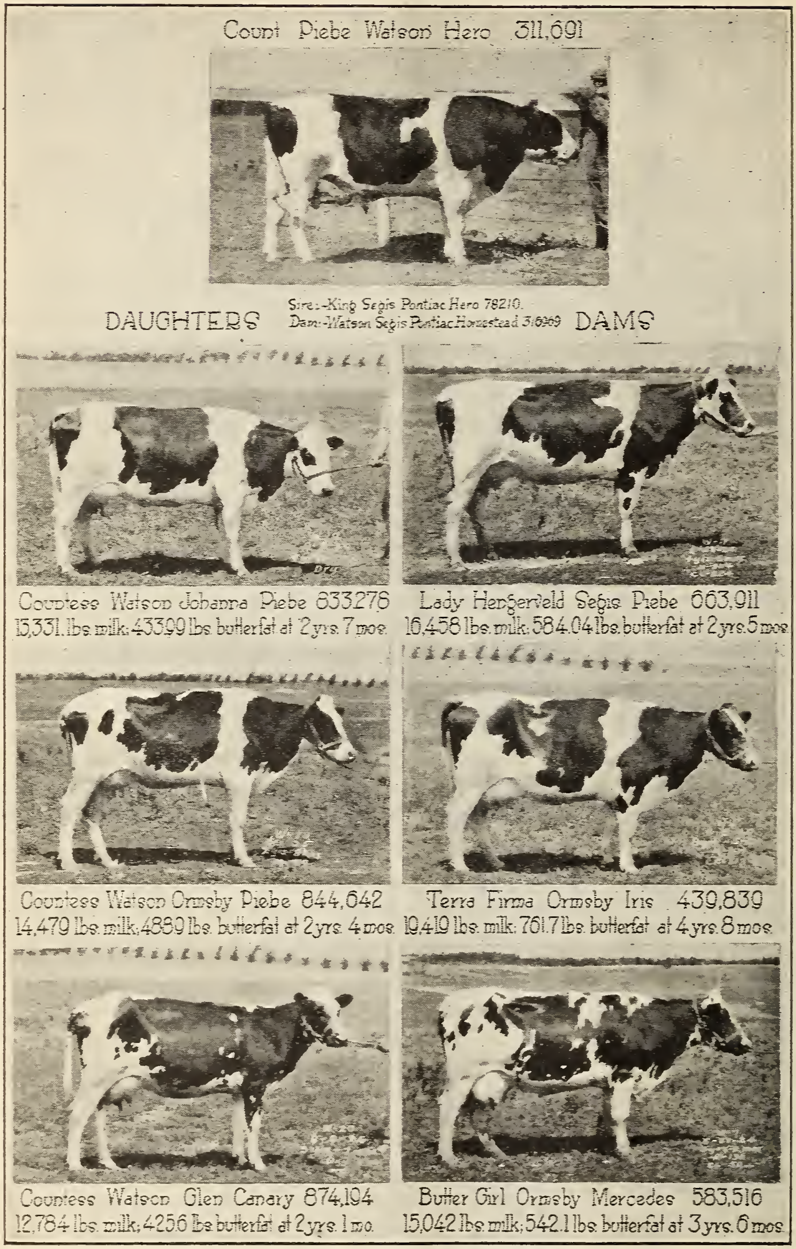
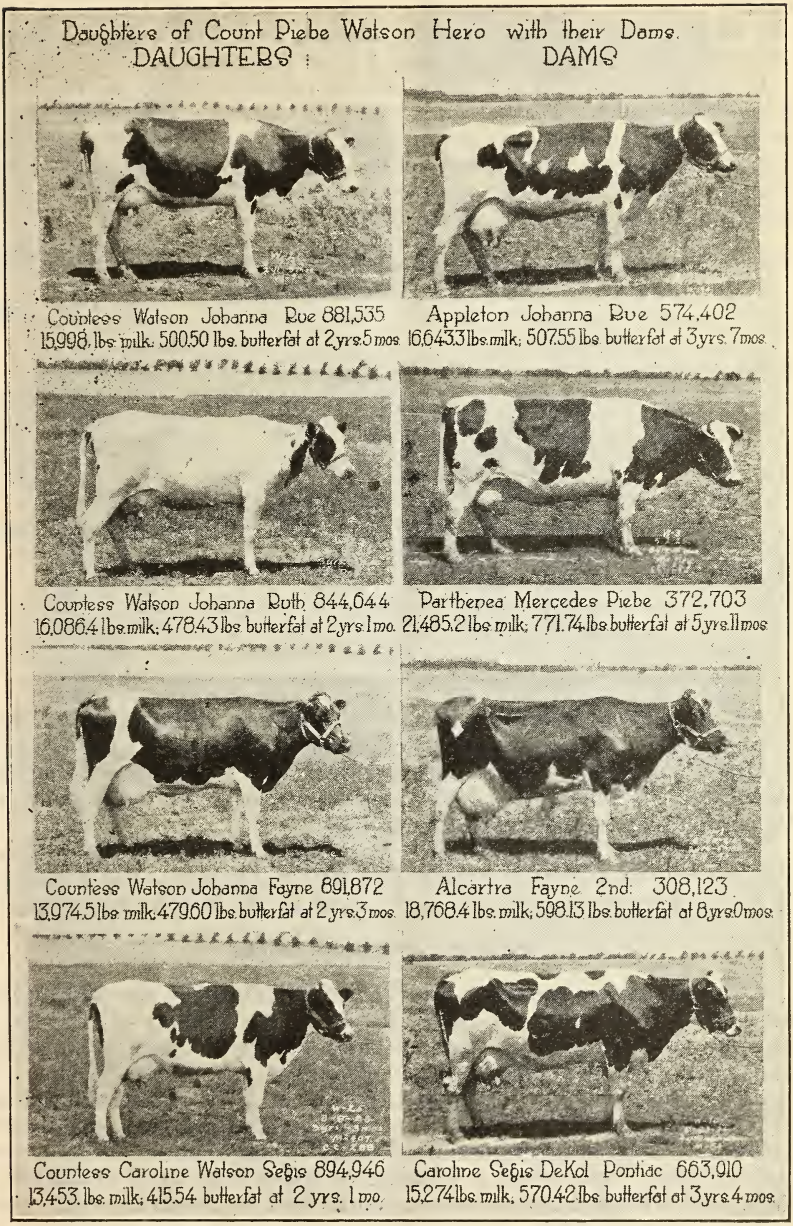

Count Piebe Watson Hero 311,691
Sire:-King Segis Pontiac Hero 78210.
Dam:-Watson Segis Pontiac Homestead 316969
DAUGHTERS
DAMS
Countess Watson Johanna Piebe 833276
15,331. lbs. milk; 433.99 lbs. butterfat at 2 yrs. 7 mos.
Lady Hengerveld Segis Piebe 663,911
16,458 lbs. milk; 584.04 lbs. butterfat at 2 yrs. 5 mos.
Countess Watson Ormsby Piebe 844,642
14,479 lbs. milk; 488.9 lbs. butterfat at 2 yrs. 4 mos.
Terra Firma Ormsby Iris 439,839
19,419 lbs. milk; 761.7 lbs. butterfat at 4 yrs. 8 mos.
Countess Watson Glen Canary 874,194
12,784 lbs. milk; 425.6 lbs. butterfat at 2 yrs. 1 mo.
Butter Girl Ormsby Mercedes 583,516
15,042 lbs. milk; 542.1 lbs. butterfat at 3 yrs. 6 mos.

FIG. 4.—Count Piebe Watson Hero with three daughters and their dams



Daughters of Count Piebe Watson Hero with their Dams.

DAUGHTERS: DAMS

Countess Watson Johanna Rue 881,535
15,998. lbs. milk; 500.50 lbs. butterfat at 2 yrs. 5 mos.

Appleton Johanna Rue 574,402
16,643.3 lbs. milk; 507.55 lbs. butterfat at 3 yrs. 7 mos.

Countess Watson Johanna Ruth 844,644
16,086.4 lbs. milk; 478.43 lbs. butterfat at 2 yrs. 1 mo.

Parthenea Mercedes Piebe 372,703
21,485.2 lbs. milk; 771.74 lbs. butterfat at 5 yrs. 11 mos.

Countess Watson Johanna Fayne 891,872
13,974.5 lbs. milk; 479.60 lbs. butterfat at 2 yrs. 3 mos.

Alcartra Fayne 2nd: 308,123
18,768.4 lbs. milk; 598.13 lbs. butterfat at 8 yrs. 0 mos.

Countess Caroline Watson Segis 894,946
13,453. lbs. milk; 415.54 butterfat at 2 yrs. 1 mo.

Caroline Segis DeKol Pontiac 663,910
15,274 lbs. milk; 570.42 lbs. butterfat at 3 yrs. 4 mos.

FIG. 5.—Four daughters of Count Piebe Watson Hero and their dams

Calamity 145857, also of the Huntley herd. She produced 823.11 pounds of butterfat in 365 days at 9 years 11 months of age. Helen Uilkje Calamity is a daughter of Johan Woodcrest Lad 52145, the sire of 11 daughters with yearly records, 2 of which have produced over 800 pounds of butterfat and 3 over 600 pounds.

In conformity with the plans of the breeding work of the bureau King Paul Helena Walker as a yearling had been placed in a grade herd at the Huntley station, in order to test his ability to transmit high milk and butterfat production. In Table 18 the records of his first six daughters which completed yearly official records are compared with the records of their dams.

TABLE 18.—*Comparison of the records of six daughters of King Paul Helena Walker 348317 with records of their dams*

Daughters				Dams			
Cow	Milk production	Butterfat production	Butterfat production calculated to maturity	Cow	Milk production	Butterfat production	Butterfat production calculated to maturity
	Pounds	*Pounds*	*Pounds*		*Pounds*	*Pounds*	*Pounds*
Beauty No. 3	11, 596	385	481	Beauty	13, 003	432	432
Dixie	8, 110	323	430	Mills	9, 984	388	388
Olive	8, 870	352	469	Martha	2, 095	96	138
Spot 2d	9, 332	335	447	Nigger	7, 836	367	403
Whitie	11, 735	444	592	Pet	5, 897	215	236
Bell	12, 197	379	473	Bess	9, 793	325	325
Average			482	Average			320

All these records were made on alfalfa hay and pasture with no grain or silage. It will be noted that each of the six daughters made a very much better record than her dam, when records of both were calculated to maturity. The average increase in production was 162 pounds of butterfat, or 50 per cent.

Judging from these records it is thought that King Paul Helena Walker will be a very successful sire and will increase the production of his daughters over that of their dams in the Woodward herd.

PROVING OF YOUNG BULLS

As a part of the breeding project the bulls born in the station herd are placed in the herds of dairy farmers in the vicinity of Woodward, in order to determine the transmitting ability of these bulls for high milk and butterfat production. The farmers receiving the bulls agree to keep records of the production of both the daughters and their dams, so that a comparison may be made of their production. Thus far, 12 bulls have been placed, but none of them thus far have been proved. However, a number of them now have daughters in milk, and within a few months records will be available with which to make comparisons.

U. S. GOVERNMENT PRINTING OFFICE: 1927